Claims

1. (currently amended) A method of machining one of a silicon body ~~(W) of~~ and a silicon wafer substrate with an ultraviolet or green visible wavelength laser beam ~~(6)~~, wherein the machining comprises machining at least one of a through via structure and a through dice lane, comprising the steps of:

   a. providing an environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids in at least a machining location of the one of a silicon body and a silicon wafer substrate;

   b. directing the laser beam at the machining location of the one of a silicon body and a silicon wafer substrate in the environment of the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids;

   c. locally heating the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids with the laser beam in the vicinity of the machining location of the one of a silicon body and a silicon wafer substrate sufficiently to cause a chemical reaction between the one of a silicon body and a silicon wafer substrate and the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids at the machining location;

   d. machining the one of a silicon body and a silicon wafer substrate at the machining location with the laser beam, thereby causing the chemical reaction to take place at the machining location to form ~~at least one of~~ gaseous and solid particle by-products; and

   e. venting ~~any~~ the gaseous by-products from the environment of the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids and dispersing ~~any~~ the solid by-products in the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids.

2. (currently amended) A method as claimed in claim 1, wherein the step of providing the environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises providing an environmental chamber ~~(2)~~ for containing the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids.

3. (currently amended) A method as claimed in claims 1 ~~or 2~~, wherein the step of providing the environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises providing a refrigerated liquid halide compound or a refrigerated liquid comprising a mixture of halocarbons and other liquids.

4. (original) A method as claimed in claim 3, wherein the step of providing the refrigerated liquid halide compound or the refrigerated liquid comprising a mixture of halocarbons and other liquids comprises controlling a temperature of the refrigerated liquid halide compound or the refrigerated liquid comprising a mixture of halocarbons and other liquids before, during and after machining.

5. (currently amended) A method as claimed in ~~any of the preceding claims~~claim 1, wherein the step of providing the environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises providing aerosol nozzle means for delivering the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids to at least the machining location.

6. (currently amended) A method as claimed ~~in any of the preceding claims~~claim 1, wherein the step of providing the environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises providing a halocarbon containing a halogen selected from the group of fluorine, chlorine, bromine and iodine.

7. (currently amended) A method as claimed in ~~any of the preceding claims~~claim 1, wherein the step of machining the one of a silicon body and a silicon wafer substrate comprises controlling a temperature of the one of a silicon body and

a silicon wafer substrate substantially to prevent thermal damage to the one of a silicon body and a silicon wafer substrate by controlling thermal loading of the one of a silicon body and a silicon wafer substrate.

8. (deleted) ~~A method as claimed in any of the preceding claims, wherein the step of machining the silicon body comprises machining at least one of a via structure, a dice lane and a scribe lane in the silicon body.~~

9. (currently amended) A method as claimed in ~~any of the preceding claims~~claim 1, wherein machining one of a silicon body and a silicon wafer substrate comprises machining a body containing a significant proportion of silicon.

10. (original) A method as claimed in claim 9, wherein the step of machining a body containing a significant proportion of silicon comprises machining a multilayer structure.

11. (original) A method as claimed in claim 10, wherein machining a multilayer structure comprises machining a multilayer structure having a plurality of layers of semiconductor, metal, interlayer dielectric and ceramic materials.

12. (currently amended) A laser machining apparatus ~~(1)~~ for machining one of a silicon body ~~of~~ and a silicon wafer substrate, wherein the machining comprises machining at least one of a through via structure and a through dice lane, comprising: an ultraviolet or green visible wavelength laser;
environment control means ~~(2)~~ for providing a controlled environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids in at least a machining location of the silicon body;
beam directing means ~~(10)~~ for directing a laser beam ~~(6)~~ from the laser onto the machining location locally to heat the liquid halide compound or ~~refrigerated liquid tetrafluoroethane or~~ the liquid comprising a mixture of halocarbons and other liquids with the laser beam in the vicinity of the machining location of the one of a silicon body and a silicon wafer substrate sufficiently to cause a chemical reaction between the one of a silicon body and a silicon wafer substrate and the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids at the machining location and to machine the silicon body at the

machining location with the laser beam, thereby causing the chemical reaction to take place at the machining location to form ~~at least one of~~ gaseous and solid particle by-products such that ~~any~~ the solid by-products are dispersed in the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids; and ~~venting means~~a gas vent ~~(5)~~ arranged to vent ~~any~~ the gaseous by-products from the environment of the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or the liquid comprising a mixture of halocarbons and other liquids.

13. (currently amended) A laser machining apparatus as claimed in claim 12, wherein the environment control means for providing the controlled environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids is arranged to provide a controlled liquid halocarbon environment.

14. (currently amended) A laser machining apparatus as claimed in claims 12 ~~or 13~~, wherein the environment control means for providing the controlled environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises environmental chamber means.

15. (original) A laser machining apparatus as claimed in claim 14, wherein the environmental chamber means comprises bath means for a refrigerated liquid halide compound.

16. (currently amended) A laser machining apparatus as claimed in claims 14 ~~or 15~~, wherein the environmental chamber means comprises an inlet port ~~(3)~~ and an outlet port ~~(4)~~ for the liquid halide compound, and a gas vent ~~(5)~~.

17. (currently amended) A laser machining apparatus as claimed in ~~any of~~ claims 14 ~~to 16~~, wherein the environmental chamber means comprises a window ~~(15)~~ transparent to the laser beam for entry of the laser beam ~~(6)~~ into the environmental chamber means.

18. (original) A laser machining apparatus as claimed in claim 17, wherein the window is anti-reflection coated.

19. (currently amended) A laser machining apparatus as claimed in ~~any of~~ claims ~~14 to 18~~, comprising refrigeration means for providing a refrigerated liquid halide compound or a liquid comprising a mixtures of halocarbons and other liquids to the environmental chamber means.

20. (original) A laser machining apparatus as claimed in claim 19, wherein the refrigeration means is arranged for controlling a temperature of the liquid halide compound or the liquid comprising a mixtures of halocarbons and other liquids before, during and after machining.

21. (currently amended) A laser machining apparatus as claimed in ~~any of~~ claims ~~12 to 20~~, wherein the environment control means for providing the environment of a liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids comprises aerosol nozzle means for delivering the liquid halide compound ~~or refrigerated liquid tetrafluoroethane~~ or a liquid comprising a mixture of halocarbons and other liquids at least to the machining location.

22. (currently amended) A laser machining apparatus as claimed in ~~any of~~ claims ~~12 to 21~~ comprising temperature control means for controlling a temperature of the one of a silicon body ~~(W)~~ and a silicon wafer substrate to be machined at the machining location, arranged substantially to prevent thermal damage of the one of a silicon body and a silicon wafer substrate by controlling thermal loading of the one of a silicon body and a silicon wafer substrate.

23. (original) A laser machining apparatus as claimed in claim 19, further comprising telecentric lens means for directing the laser beam, wherein a flow of the refrigerated liquid halide compound substantially fills a field of view of the telecentric lens means.

24. (new) A method as claimed in claim 1, wherein the step of providing an environment of a liquid halide compound or a liquid comprising a mixture of halocarbons and other liquids comprises providing an environment of tetrafluoroethane.

25. (new) A laser machining apparatus as claimed in claim 12, wherein the environment control means for providing a controlled environment of a liquid halide compound or a liquid comprising a mixture of halocarbons and other

liquids comprises environment control means for providing a tetrafluoroethane environment.

Respectfully Submitted

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